June 1999

Willamette River

Sediment Sampling Evaluation

Abstract

The Clean Water Act (CWA) of 1977, as amended regulates dredging activities and requires sediment quality evaluation, including testing, prior to dredging. Guidelines to implement 40 CFR Part 230-Section 404(b)(1) regulations of the CWA, the national Inland Testing Manual (ITM) and the regional Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF) have adopted a tiered testing approach for the evaluation of dredge material. The Tier IIa (physical testing) and Tier IIb (chemical testing) have been completed for this evaluation. The screening levels (SL) used are those adopted in the DMEF.

Prior to potential maintenance dredging, nine vibra-core sediment samples were collected from the Willamette River, river mile (RM) 2+10 and RM 8+30 to 9+35, April 28, 1999 (see figure 1 for locations). All samples were sent to Sound Analytical Services, Inc. laboratory of Tacoma, WA, for physical and chemical analyses, to include: metals, total organic carbon (TOC), pesticides/polychlorinated biphenyls (PCBs), herbicides, phenols, phthalates, miscellaneous extractables, polynuclear aromatic hydrocarbons (PAHs), tributyltin (TBT) and dioxin/furan

One or more contaminates were detected above the DMEF screening levels in the three potential dredge sites. At RM 2+10 (Oregon Steel Mill dock) DDT was detected within the proposed dredging prism. A strong petroleum odor was detected in the core approximately 5 feet below the dredging prism. Tributyltin (TBT) was detected above the SL in the shoal at RM 9 to 9+35. Both DDT and TBT were detected above the SL at RM 8+40 (Texaco dock).

The sediment represented by the samples that exceeded the SL of the DMEF can not be determined to be suitable for open in-water disposal without further characterization at Tier III (biological testing) level.

Introduction

The purpose of this report is to characterize the sediment of portions of the Willamette River navigation channel for the purpose of maintenance dredging based on the sampling event described. The sampling and analysis objectives are listed below. This report will outline the procedures used to accomplish these goals.

SAMPLING AND ANALYSIS OBJECTIVES

The sediment characterization program objectives and constraints are summarized below:

- To characterize sediments in accordance with the regional dredge material testing manual, the Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF).

- Collect, handle and analyze representative sediment, of the purposed dredging prism, in accordance with protocols and Quality Assurance/Quality Control (QA/QC) requirements.

- Characterize sediments to be dredged for evaluation of environmental impact.

- Only physical and chemical characterization will be conducted for this sediment evaluation.

Previous Studies

The Columbia and Lower Willamette (C&LW) Federal project is a deep-draft channel that is authorized to a depth of 40 feet, but the entire channel is not maintained to that depth. The project extends from the mouth of the Willamette to the Broadway Bridge located at approximate (RM 11.7). The project channel is between 600 and 1900 feet wide. Sediment below the SL has historically been disposed in-water at the Morgan Bar dispersive site at RM 100 on the Columbia River. Some material has gone to a confined in-water site and about 10,000 cubic yards went upland on Port of Portland property.

Sediment evaluations of shoals in the channel were conducted in 1988, 1992 and 1996. The 1988 study was an extensive survey in which 22 samples were collected. Both Tier II chemical and Tier III biological tests were performed on the sediment. Most of the sediment, including that between RM 8.0 and 10.1, was found acceptable for unconfined in-water disposal.

In 1996 TBT was detected in all of the samples testing for total (bulk) TBT. The level of bulk TBT was below the level of concern and the material approved for in-water disposal.

In 1998 during permit dredging (around the water intake) at the Oregon Steel Mill dock (RM 2+10), an oil sheen was detected on the water surface during the dredging activity, the site was contained and all dredging was suspended. The dredging area is approximately 750 feet to the east of where the dredging area being evaluated in this report is located (see figure 2).

The 1997 sediment-sampling event for Columbia River Channel Deepening Feasibility Study collected 1 surface sample at RM 2.05 (WR-BC-09) mid-channel. A gravity core sample (WR-GC-30) was taken at RM 8.5 in the channel near Texaco Dock and an additional sample (WR-GC-31) was collected in the channel at RM 8.9. Low levels of some contaminants of concern were detected, but none exceeded the DMEF screening levels for open in-water disposal. These were the only samples from the CRCD study near the areas associated with this evaluation.

Current Sampling Event

The Corps of Engineers, Portland District personnel and Marine Sampling Systems (MSS) collected 9-vibra core samples on April 28, 1999 using MSS boat and vibra core system. All cores were divided into three four foot lengths, lettered "A" – "C" by depth. The top two section ("A" and "B"), representing the dredge prism were composited at the lab and the lower section "C") was archived for possible future reference. Sample WR-VC-08C was an exception to the above protocol. Sample 08C was analyzed because it contained a petroleum odor. The material sampled for potential dredging was divided into 3 dredge material management units (DMMUs). Two core samples were collected from the DMMU on the east side of the channel at the Oregon Steel Mill dock, RM 2 +10 to 2+20, representing approximately 50,000 cy. Two additional core samples were collected from a second DMMU, which includes a shoal on the west side of the channel from RM 9 to 9+40, representing approximately 80,000 to 100,000 cubic yards. Five core samples were, also, collected from a third DMMU which consisted of a wedge shaped area in front of the Texaco Dock on the west side of the river at RM 8+30 to 8+50. These samples represented 250,000 to 350,000 cubic yards of dredge material.

The samples varied in color from brown to gray and were classified as " silt". The median grain size for all sediment collected was 0.04mm, with 35.2% sand and 63.7% fines. Samples were sent to Sound Analytical Services laboratory in Tacoma, WA, for physical and chemical analyses, to include: metals, organotin (TBT) (samples 02,03,05 only), total organic carbon (TOC), pesticides/PCBs, Dioxin/furan (samples 02 & 05 only), herbicides, phenols, phthalates, miscellaneous extractables, polynuclear aromatic hydrocarbons (PAHs).

The first two samples (WR-VC-01 & 02) were collected from a shoal on the east edge of the main channel at RM 2+10 to 2+20 (Oregon Steel Mill dock). This sampling area was designated DMMU – 1 and represented approximately 50,000 cubic yards. The cores penetrated 13 feet yielding 11'7" and 11'2" cores, respectively. DDT in sample 02 (composite of A & B) was detected at 11.3 ug/kg concentration (SL=6.9ug/kg). A strong petroleum odor was detected in WR-VC-01C. The odor was approximately 5 feet below the 4'6" dredging prism. As the 01C sample represented sediment below the dredging prism it was not analyzed, but archived if needed for analyses.

Samples WR-VC-03 & 04, representing DMMU – 2, approximately 80,000 to 100,000 cubic yards,, were collected from a shoal on the west edge of the main navigational channel from RM 9 to 9+35. These cores were 10'6" and 11'7" in length. Analyses for TBT (pore water) in sample 03 was above the 0.15 ug/L SL, at 0.315 ug/L concentration.

Samples WR-VC-05 through 09 were collected in front of the Texaco dock (RM 8+30 to 8+50) representing the up to 350,000 cubic yards designated as DMMU - 3. The cores were 11'6", 12', 12', 11'10" and 12'1" long. TBT was detected above the SL for sample 05 at 0.60ug/kg concentration. Analysis for sample 08C exceeded the SL for DDT with a 7.1-ug/kg concentration.

Sampling and analyses were performed using proper quality control measures, including proper procedures for chain of custody, preservation and cooler receipt. All laboratory QC is acceptable. All reported values in excess of the SL were checked for proper laboratory method calculation and in the case of DDT underwent a second column confirmation.

Results/Discussion

Physical and Volatile Solids: Data for these analyses are presented in Table 1. All 9 samples submitted for analysis exceeded 20% fines with eight exceeding 5% volatile solids. All samples submitted were classified as "silt" (ML). Median grain size for all samples is 0.04 mm, with 35.2% sand and 63.7% fines. All samples were brown to gray in color with petroleum odor and sheen in samples WR-VC-01C & 08C (see PAHs below for more discussion).

Metals, Total Organic Carbon (TOC): Data for these analyses are presented in Table 2. Low levels of some metals were found in most of the samples collected, but levels do not approach the SL. The highest level detected was for mercury, which is 73% of the SL. As, Cu, Ni, and Zn were detected in all samples, but at levels less than 41% of the SL.

Organotin (TBT): Data for these analyses are presented in Table 2. Tributyltin (TBT) and its breakdown products (dibutyltin & monobutyltin) were detected above SL in samples WR-VC-03 & 05. Only three samples were analyzed for TBT, one from each major area sampled, RM 2+10 (WR-VC-02), one from the shoal at RM 9 to 9+35 (WR-VC-03) and one in front of the Texaco dock at RM 8+40 (WR-VC-05).

Pesticide/PCBs, Phenols, Phthalates, Herbicides, Dioxin/Furan and Misc. Extractables: Data for these analyses are presented in Table 3. No herbicides or PCBs were found at the method detection limits. Three phenols were detected at levels < 45% of the SL. Four phthalates were detected at levels <5% of SL. Benzoic Acid, benzylalcohol and dibenzofuran were found at levels < 16% of SL. Total DDT and it's breakdown products, DDD and DDE were detected above the 6.9 ug/kg SL, in sample WR-VC-02 (RM2+10 Oregon Steel Mill dock) at 11.3 ug/kg and WR-VC-08C (RM 8+40 Texaco dock) at 7.1 ug/kg.

Polynuclear Aromatic Hydrocarbons (PAHs): Data for these analyses are presented in Tables 4 & 5. Low levels of some individual "low molecular weight" PAHs were found in all samples at levels <10.4% of SL. Low levels of most of the "high molecular weight" PAHs were found in all samples at levels <8.8% of the SL. Sample WR-VC-08C had a petroleum odor, but did not show PAHs above the SL when analyzed. Sample WR-VC-01C had a strong petroleum odor from 10'10" to 11'7". This depth was well below the dredging prism of 4'6" and was not analyzed, but was submitted as a sample to be archived for potential future reference.

Dioxin/Furan: Data for these analyses are presented in Table 6. This method provides procedures for the detection and quantitative measurement of polychlorinated dibenzo-p-dioxins (tetra- through octachlorinated homologues; PCDDs), and polychlorinated dibenzofurans) (tetra- through octachlorinated homologues; PCDFs) in a variety of environmental matrices and at part-per-trillion (PPT) concentrations. The PCDDs include 75 individual compounds, and the PCDFs include 135 individual compounds. These individual

compounds are technically referred to as congeners. Only 7 of the 75 congeners of PCDDs are thought to have "dioxin-like" toxicity; these are ones with chlorine substitutions in, at least, the 2,3,7,8 positions. Only 10 of the 135 possible congeners of PCDFs are thought to have "dioxin-like" toxicity: these also are ones with substitutions in the 2,3,7,8 positions. For risk assessment purposes, a toxicity equivalency procedure was developed to describe the cumulative toxicity of these mixtures. This procedure involves assigning individual toxicity equivalency factors (TEFs) to the PCDD and PCDF congeners. These TEF values have been adopted by international convention (U.S. EPA, 1989: Ahlborg, et al., 1994). TEFs are estimates of the toxicity of dioxin-like compounds relative to the toxicity of 2,3,7,8-TCDD, which is assigned a TEF of 1.0. All other congeners have lower TEF values ranging from 0.5 to 0.001 for dioxin/furans. Calculating the toxic equivalency (TEQ) of a mixture involves multiplying the concentration of individual congeners by their respective TEF. The sum of the TEQ concentrations for the individual congeners is the TEQ concentration for the mixture.

Samples WR-VC-02 and WR-VC-05 were the only samples analyzed for Dioxin/Furans. The TEQs* for sample WR-VC-02; all dioxins = 2.964 pptr and all furans = 0.157 pptr, for sample WR-VC-05; all dioxins = 3.55 pptr and all furans = 0.1836 pptr. These TEQ values are well below the guidance level of < 5 pptr TCDD and <15 pptr TEQ determined to be suitable for unconfined open water disposal.

*If the ecological TEF was unknown the human health TEF was used to calculate TEQ.

Conclusion

Collection and evaluation of the sediment data was completed using guidelines from the Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF). The DMEF is a regional manual developed jointly with regional EPA, Corps, Oregon Dept. of Environmental Quality and Washington Depts. of Ecology and Natural Resources. This document is a guideline for implementing the Clean Water Act, 40 CFR 230 sec 404 (b)(1). The screening levels used are those adopted for use in the DMEF, final November 1998. The DMEF Tiered testing approach requires that material in excess of 20% fines and greater than 5% volatile solids, as well as any material with prior history or is suspected ("reason to believe") of being contaminated, be subjected to chemical as well as physical analyses. Under the Tiered approach, if the chemical analytical results do not exceed the established screening levels (SL), the material is considered suitable for unconfined in-water disposal.

The shoal at DMMU – 1 (RM 2+20), the Oregon Steel Mill dock, indicated DDT in the WR-VC-02 (11.3 ug/kg) sample to be above the SL (6.9 ug/kg). Possible PAH contamination was observed in the WR-VC-01 sample, at DMMU – 1, which was not analyzed as it was at level 3' 6", five feet below the dredging prism. DDT also exceeded the SL in one other sample (WR-VC-08C) (7.1 ug/kg) collected in front of the Texaco dock at RM 8+40 at DMMU - 3. Only three samples were analyzed for TBT, one from each DMMU, RM 2+10 (WR-VC-02), RM 9 to 9+35 (WR-VC-03) and RM 8+40 (WR-VC-05). Two of the 3

samples (WR-VC-05 at 0.315 ug/L and WR-VC-05 at 0.60 ug/L) analyzed for TBT exceeded the 0.15 ug/L screening level.

The sediment from all 3 DMMUs, represented by this sampling event, can not be determined to be suitable for open in-water disposal without further characterization at the Tier III (biological testing) level.

References

1. U.S. army Corps of Engineers, Portland District, Seattle District; U.S. Environmental Protection Agency, Region 10; Oregon Department of Environmental Quality; Washington State Department of Natural Resources and Department of Ecology. 1998 Final. Dredge Material Evaluation Framework for the Lower Columbia River Management Area.

2. U. S. Environmental Protection Agency and U. S. Army Corps of Engineers. February 1998. Evaluation of Dredged Material Proposed for Discharge in Inland and Near Coastal Waters – Testing Manual, dated (referred to as the "Inland Testing Manual").

3. The Clean Water Act, 40 CFR 230 (b) (1).

4. U.S. army Corps of Engineers, Portland District. 1988. Results of 1988 Lower Willamette River Sediment Quality Testing—USACE Portland Districting O&M Dredging.

5. U.S. army Corps of Engineers, Portland District. 1992. Lower Willamette River Sediment Evaluation – Portland Harbor.

6. U.S. army Corps of Engineers, Portland District. 1992. Columbia and Lower Willamette River Project, Lower Willamette River, Portland Harbor Sediment Evaluation, November 1996.

Table 1, Willamette River **Sampled April 28, 1999**

Physical Analysis

	Grain Size (mm)				%					
Sample I.D.	**Median**		**Mean**		**Gravel**	**Sand**	**Silt/Clay**	**Volatile solids**		
WR-VC-01	0.03		0.16		1.1	24.9	74.0		7.96	
WR-VC-02	0.03		0.21		1.0	31.4	67.5		7.79	
WR-VC-03	0.04		0.10		0.2	29.5	70.3		7.53	
WR-VC-04	0.05		0.20		2.0	41.7	56.4		6.69	
WR-VC-05	0.04		0.27		2.9	42.1	55.1		7.86	
WR-VC-06	0.06		0.19		1.3	43.7	55.1		7.66	
WR-VC-07	0.05		0.11		0.8	32.5	66.7		6.58	
WR-VC-08	0.05		0.22		2.0	31.9	66.1		4.79	
WR-VC-09	0.04		0.09		0.4	31.6	67.9		7.12	
WR-VC-09-Lab Dup.	0.05		0.09		0.0	42.2	57.8		6.89	
Mean	0.04		0.16		1.2	35.2	63.7		7.09	
Minimum	0.03		0.09		0.0	24.9	55.1		4.79	
Maximum	0.06		0.27		2.9	43.7	74.0		7.96	

Table 2, Willamette River **Sampled April 28, 1999**

Inorganic Metals, TOC and TBT

Sample I.D.	As	Sb	Cd	Cu	Pb	Hg	Ni	Ag	Zn	TOC	TBT
	mg/kg (ppm)										ug/L
WR-VC-01	3.8	<85	<0.18	40	<14	<0.14	24	<0.053	170	24000	-
WR-VC-02	3.3	<91	<0.19	34	<18	<0.16	17	<0.058	87	19000	<0.017
WR-VC-03	4.1	<100	<0.21	39	<17	<0.13	21	<0.065	93	22000	**0.315**
WR-VC-04	3.1	<76	<0.16	30	<13	0.14	17	<0.048	88	19000	-
WR-VC-05	3.6	<72	<0.15	37	<12	0.11	20	0.068	93	12000	**0.60**
WR-A (DUP-05)	2.4	<87	<0.18	37	<14	0.19	24	<0.055	83	20000	-
WR-VC-06	3.7	<77	<0.16	34	<13	<0.11	23	<0.048	96	15000	-
WR-VC-07	3.3	<74	<0.15	33	<12	0.3	21	<0.047	93	24000	-
WR-VC-08	3.8	<80	<0.17	40	<13	<0.15	21	0.1	110	23000	-
WR-VC-08C	3.1	<69	<0.14	33	<12	0.12	21	<0.044	170	17000	-
WR-VC-09	3.8	<80	<0.17	41	<13	0.22	20	0.24	110	20000	-
Screening level (SL)	57	150	5.1	390	450	0.41	140	6.1	410		0.15
Mean	3.5	ND	ND	36.2	ND	0.098	20.8	0.04	108.5		**0.31**
Maximum	4.1	ND	ND	41	ND	0.3	24	0.24	170		**0.60**

Symbol (-) = Indicates analysis not run.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Pesticides/PCBs, Phenols, Phthalates, Herbicides and Extractables

Sample I.D.	Pesticides				Phenols			Phthalates				Extractables		
	ug/kg (ppb)													
	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT	Pentachlorophenol	3-&4-Methylphenol	Phenol	bis(2-Ethylhexzylphthalate	Butylbenzylphthalate	Di-n-butylphthalate	Di-n-octylphthalate	Benzoic Acid	Benzyl Alcohol	Dibenzofuran
WR-VC-01	<0.27+	<0.57+	<2.1=	ND	21	28	<3.7	31	<1.8	<3.8	<2.4	<8.1	<6	9.7
WR-VC-02	**5.4+**	**5.9+**	<2.1=	**11.3**	19	24	<3.7	34	<1.8	<3.8	<2.4	<8.1	7.3	<3.7
WR-VC-03	<0.27+	<0.57+	<2.1=	ND	67	20	<3.7	50	<1.8	<3.8	13	<8.1	8.8	<3.7
WR-VC-04	<0.27+	<0.57+	<2.1=	ND	3.2	52	4.9	40	54	<3.8	<2.4	<8.1	<6	<3.7
WR-VC-05	<0.27+	<0.57+	<2.1=	ND	9.4	48	<3.7	47	<1.8	5	<2.4	<8.1	<6	<3.7
WR-A (DUP-05)	<0.27+	<0.57+	<2.1=	ND	13	4.8	<3.7	11	3.8	4.4	<2.4	<8.1	<6	<3.7
WR-VC-06	<0.27+	<0.57+	<2.1=	ND	16	15	<3.7	40	<1.8	4.6	<2.4	9.7	5.7	<3.7
WR-VC-07	<0.27+	<0.57+	<2.1=	ND	16	29	<3.7	39	3.8	5	<2.4	<8.1	7.3	<3.7
WR-VC-08	<0.27+	<0.57+	<2.1=	ND	15	33	5.1	33	19	6	<2.4	8.7	<6	<3.7
WR-VC-08C	**3.1+**	**4+**	<2.1=	**7.1**	22	16	<3.7	33	<1.8	7.6	<2.4	<8.1	<6	<3.7
WR-VC-09	<0.27+	5.9+	<1.8=	5.9	47	300	8.4	60	7.8	5.3	<2.4	<8.1	9	<3.7
Screen level (SL)	DDD + DDE + DDT =			6.9	400	670	420	8300	1200	5100	6200	650	57	540
Mean	0.77	1.44	ND	2.21	22.6	51.8	1.7	38	8.1	3.4	1.2	1.7	3.5	0.9
Maximum	5.4	5.9	ND	11.3	67	300	8.4	60	54	7.6	13	9.7	9	9.7

Values detected for DDT were confirmed with second column.

PCBs = Non-detect (ND) <18.0 ppb (SL = 130 ppb).

Chlorinated Herbicides (Method 8151) = Non-detect (ND) <19.0 ppb, (SL has not been set).

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Polynuclear Aromatic Hydrocarbons (PAHs)

Low Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Acenapththene	Acenaphthylene	Anthracene	Fluorene	2-Methyl napthalene	Naphthalene	Phenanthrene	Total Low PAHs
WR-VC-01	52	23	40	27	23	30	150	345
WR-VC-02	12	6.3	11	6.9	<2.9	4.1	45	85.3
WR-VC-03	<2.2	9.5	<3	<2.9	<2.9	<2.3	3.7	13.2
WR-VC-04	<2.2	3.6	4.3	<2.9	<2.9	15	17	39.9
WR-VC-05	<2.2	<2.2	3	<2.9	<2.9	5	13	21
WR-A (DUP-05)	<2.2	<2.2	<2.1	<2.9	<2.9	<2.3	<2.4	ND
WR-VC-06	<2.2	4.3	3.4	<2.9	<2.9	<2.3	12	19.7
WR-VC-07	<2.2	<2.2	<2.1	<2.9	<2.9	<2.3	7.3	7.3
WR-VC-08	<2.2	<2.2	3.6	<2.9	<2.9	6.3	9.6	19.5
WR-VC-08C	<2.2	6.7	3.5	<2.9	<2.9	3.7	10	23.9
WR-VC-09	3.1	5.9	7.8	3.9	<2.9	11	24	5.1
Screen level (SL)	500	560	960	540	670	2100	1500	29000
Mean	6.1	5.4	7.0	3.4	2.1	6.8	26.5	
Maximum	52	23	40	27	23	30	150	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Polynuclear Aromatic Hydrocarbons (PAHs)

High Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Benzo(a) anth racene	Benzo(b) fluro anthene	Benzo(k) fluro anthene	Benzo(g,h,i) perylene	Chrysene	Pyrene	Benzo(a) pyrene	Dibenz(a,h) anthracene	Indeno (1,2,3-cd) pyrene	Fluoran thene	Total High PAHs
WR-VC-01	56	76	23	50	65	160	96	<2.9	23	150	699.0
WR-VC-02	17	27	7.3	17	17	47	20	<3.2	17	40	209.3
WR-VC-03	3.7	8.1	<2.6	<2.1	<3.3	8.1	<2.1	<1.9	<2.4	6.7	26.6
WR-VC-04	9.7	<2.5	<2.2	13	11	24	<1.8	<1.6	6.9	21	85.6
WR-VC-05	4.7	13	<2.1	<1.7	8.5	18	4.7	<1.6	5.5	17	71.4
WR-A (DUP-05)	<2.9	<2.7	<2.5	<2.0	<3.1	5.1	<2.0	<1.8	<2.3	3.8	8.9
WR-VC-06	9.4	13	4.8	<1.8	13	23	<1.8	<1.6	<2.1	26	98.1
WR-VC-07	5.3	7.9	<2.3	<1.8	8.2	14	8.5	<1.7	<2.1	12	55.9
WR-VC-08	11	9	3.3	6.3	6.9	17	13	<1.7	7.2	19	92.7
WR-VC-08C	9	5.3	7.6	7.2	12	18	5.1	<1.3	<1.7	17	81.2
WR-VC-09	19	25	8.4	13	21	41	17	<1.6	14	37	195.4
Screen level (SL)	1300	3200		670	1400	2600	1600	230	600	1700	12000
Mean	13.2	21.7		9.7	14.8	34.1	14.9	ND	6.7	31.8	
Maximum	56	99		50	65	160	96	ND	23	150	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Table 6, Willamette River **Dioxins/Furans (pg/g, pptr)** **Sampled April 28, 1999**

Sample I.D.	Dioxin/Furan	TEF	Result	TEQ	Guidance Level
WR-VC-02	1,2,3,6,7,8-HxCDD	0.024	11	0.264	
	1,2,3,6,7,9-HxCDD	0.1*	5.2	0.52	
	Total (other)HxCDD	0	58	0	
	1,2,3,4,6,7,8-HpCDD	0.002	190	0.38	
	Total (other) HpCDD	0	360	0	
	OCDD	0.001*	1800	1.8	
Total Dioxins TEQ				2.964	<5.0
	2,3,7,8-TCDF	0.028	3.0	0.084	
	Total TCDF	0	16	0	
	Total (other) PeCDF	0	17	0	
	Total (other) HxCDF	0	41	0	
	1,2,3,4,6,7,8-HpCDF	0	25	0	
	Total (other) HpCDF	0	94	0	
	OCDF	0.001*	73	0.073	
Total Furans TEQ				0.157	<15.0
WR-VC-05	1,2,3,6,7,8-HxCDD	0.024	15	0.36	
	1,2,3,6,7,9-HxCDD	0.1*	7.5	0.75	
	Total (other)HxCDD	0	90	0	
	1,2,3,4,6,7,8-HpCDD	0.002	220	0.44	
	Total (other) HpCDD	0	420	0	
	OCDD	0.001*	2000	2	
Total Dioxins TEQ				3.55	<5.0
	2,3,7,8-TCDF	0.028	3.2	0.0896	
	Total TCDF	0	25	0	
	Total (other) PeCDF	0	23	0	
	Total (other) HxCDF	0	49	0	
	1,2,3,4,6,7,8-HpCDF	0	33	0	
	Total (other) HpCDF	0	54	0	
	OCDF	0.001*	94	0.094	
Total Furans TEQ				0.1836	<15.0

TEQ = Toxicity Equivalency Quotient
TEF = Toxicity Equivalency Factors
*If the Ecological TEF was unknown the human health TEF was used to calculate TEQ.

Figure 1, General Sampling Site Map

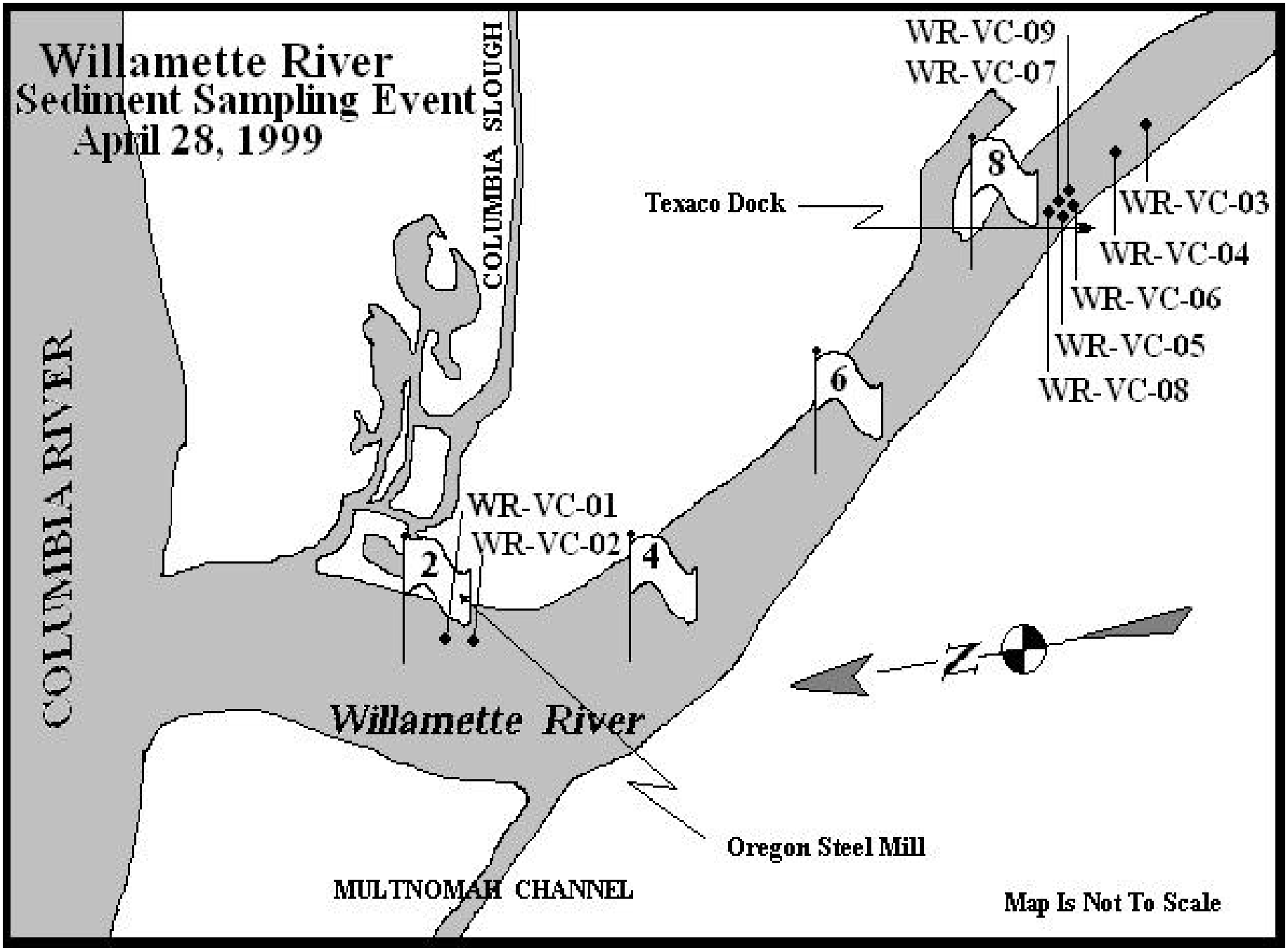

Figure 2, River Mile 2 Sampling Site

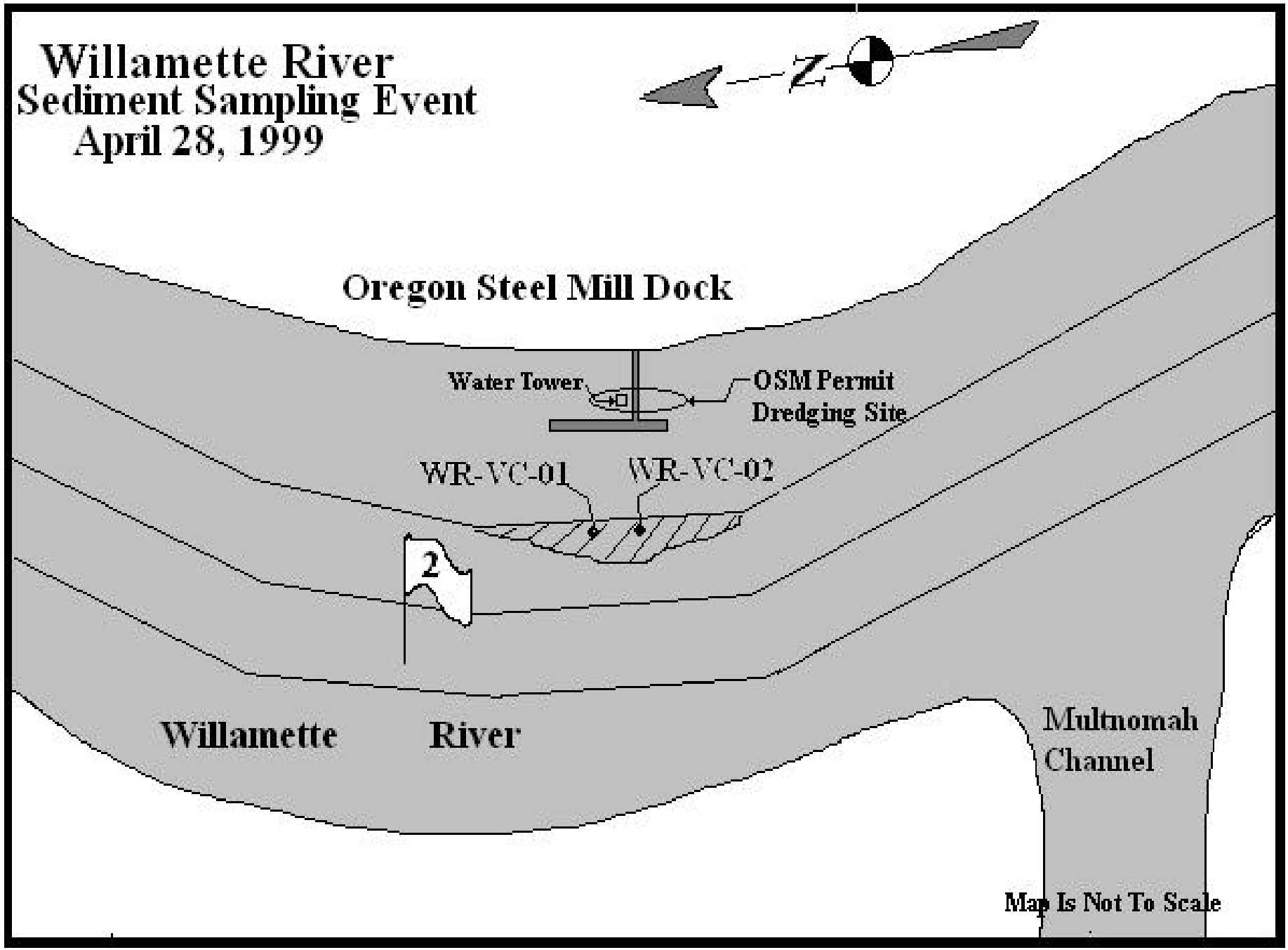

Figure 3, River Mile 8 to 10 Sampling Site Map